

Novel Real-Time Flight Envelope Monitoring System, Phase I

Completed Technology Project (2009 - 2010)



Project Introduction

The proposed innovation is an aircraft flight envelope monitoring system that will provide real-time in-cockpit estimations of aircraft flight envelope boundaries, performance, and controllability. The adaptable monitoring system will provide information on current and predicted aircraft performance and controllability, alerting the pilot to any aerodynamic degradation of the control effectiveness. This includes high angle-of-attack, heavy rain, in-flight icing encounters, environmental contamination of surfaces, and structural or battle damage. The real-time monitoring system measures the time-averaged and RMS control surface hinge moment from all aircraft aerodynamic controls. Control surface hinge moment is sensitive to the aerodynamic characteristics of the flying surface, including separation. These data are processed and information on the current and predicted future state of aircraft control (including asymmetric cases) is made available to the pilot or flight management system. As opposed to other single-point monitoring systems, the proposed system has the distinct advantage that it functions by measuring the integrated effect over the entire control surface. The use of real-time control surface hinge moment monitoring is an innovative and robust concept for predicting aircraft flight envelope boundaries and controllability.

Anticipated Benefits

The successful development of a control surface hinge moment based flight envelope monitoring system has a large potential for use on both existing and future air vehicles, including general aviation, military, commercial planes, and especially unmanned aircraft systems and commuter and turbo prop cargo aircraft. Commuter class and smaller cargo aircraft would be a very valuable application of the flight envelope monitoring system. These aircraft typically operate from smaller airports and spend a greater percentage of their flight time at lower altitudes and airspeeds. Operation at lower altitudes and airspeeds put the aircraft at greater risk of experiencing environmental or structurally based aerodynamic performance degradation, including ice accumulation, storm and rain encounters, and even bird strikes. The technology is equally valuable for unmanned platforms where it is difficult for a remote operator to sense envelope boundaries or any difference in performance due to environmental or battle damage. The flight envelope monitoring system can aid this class of aircraft either as a standalone warning system, or it can be licensed to the aircraft manufacturer and be built into a more complex, integrated system. The proposed control surface hinge moment based flight envelope monitoring system technology is synergistic with the national priorities in aerospace R/R&D. The new technology will mitigate environmental hazards for future operational concepts and provide increased safety for the expansion of flight envelopes for aerospace vehicles. The flight envelope monitoring system will provide state-of-the-art on-board envelope assessment including continuous diagnosis and prognosis. The proposed envelope monitoring system has significant potential application in



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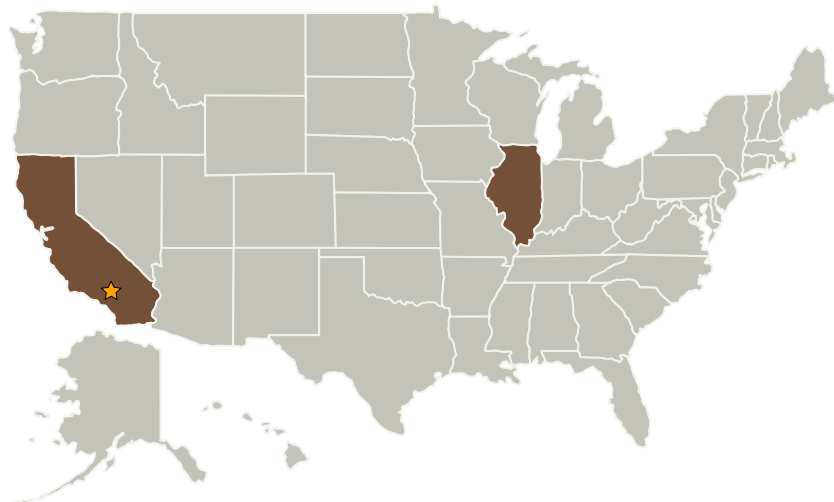
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several NASA programs. The robust and integrated sensing technology could be fielded in both manned and unmanned NASA aircraft systems.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Armstrong Flight Research Center(AFRC)	Lead Organization	NASA Center	Edwards, California
Rolling Hills Research Corporation	Supporting Organization	Industry	El Segundo, California

Primary U.S. Work Locations

California	Illinois
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Project Transitions

**January 2009:** Project Start**January 2010:** Closed out

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Armstrong Flight Research Center (AFRC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Manager:

Mark C Davis

Principal Investigator:

Michael Kerho

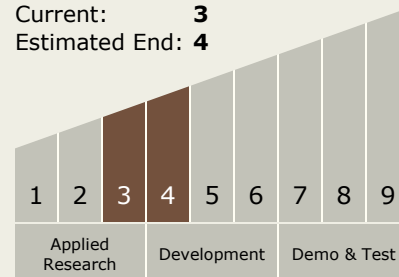
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Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **4**



Technology Areas

Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
 - └ TX17.2 Navigation Technologies
 - └ TX17.2.3 Navigation Sensors